Rotterdam, 22-6-17

- Current innovations in the Dutch Biobased Economy.

- Kees de Gooijer (“Case”)
- CIO TKI-BBE, TKI-A&F

TKI: Topconsortium for Knowledge and Innovation
CIO: Chief Inspiration Officer
BBE: Biobased Economy, A&F: Agri & Food

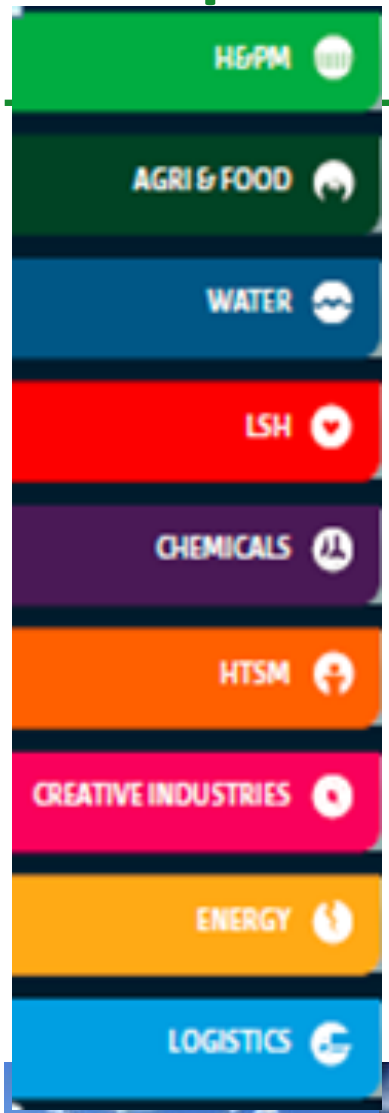
Content


Introduction
Stories
Even more stories
There will be no wrap-up !
Take-Home Messages as we go

A TKI?

- The elevator pitch:
- The TKI builds, maintains and executes a research & innovation agenda for the BBE, over all TRL's (so, from basic research to vaorisation).
- Part of the dutch topsector policy.

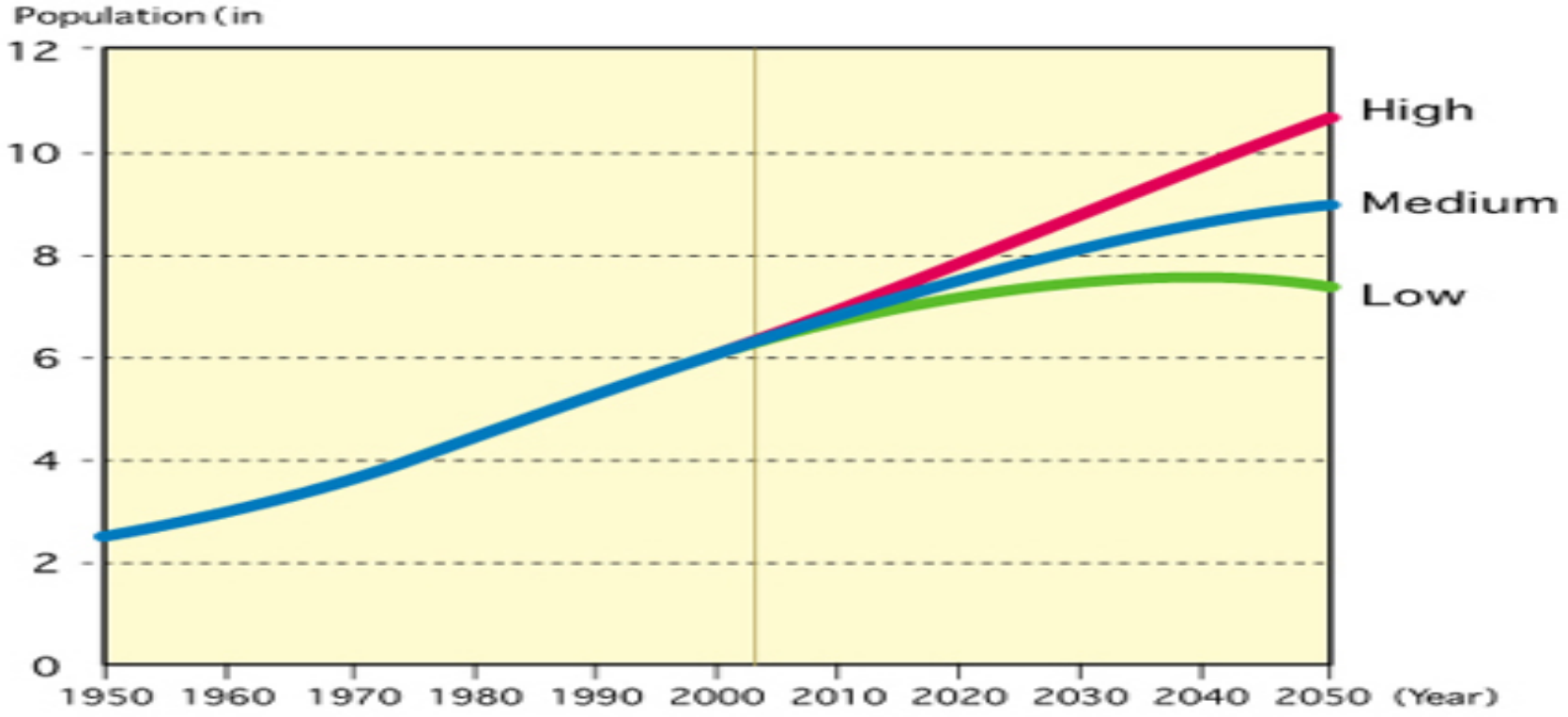
Topsectors?



- Combine public and private investments in Research and Innovation.
- This includes the public investments in applied research institutes (35-100% of their budget).
- This includes the public investments in scientific research (the national science foundation NWO) to universities (50% of the budget (275 M€) of which 1/3 is under direct dialogue).
- Unique in Europe, example Japan and Korea.

Agri&Food: Two views...

Figure 1 United Nations World Population Projections, 1950-2050
Source: World Population Prospects



TKI BBE in Topsectors

TS Energy

TKI Energo/ S2SG/Solar

TKI Gas / ISPT

TKI Wind on Sea

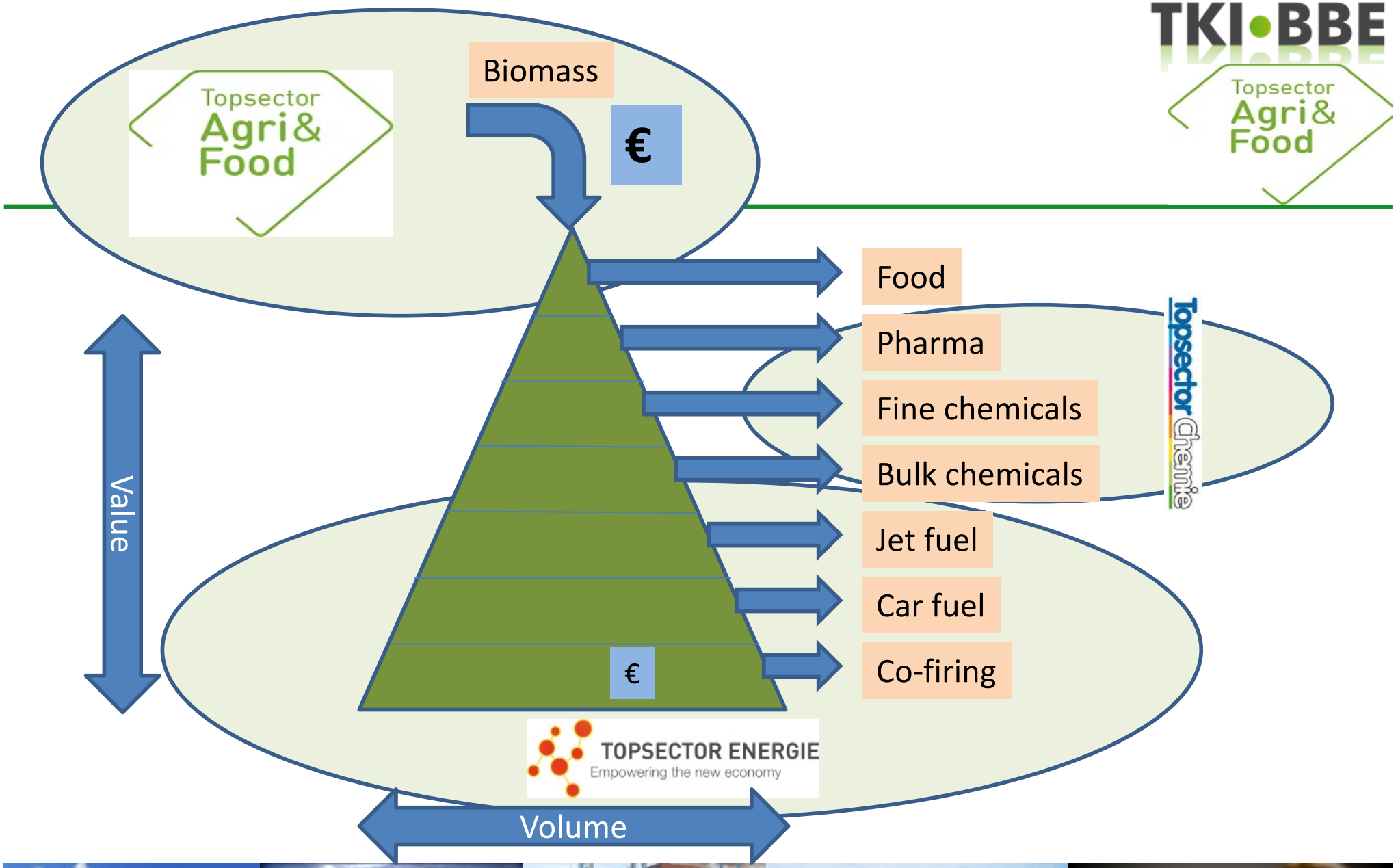
TS Agri&Food

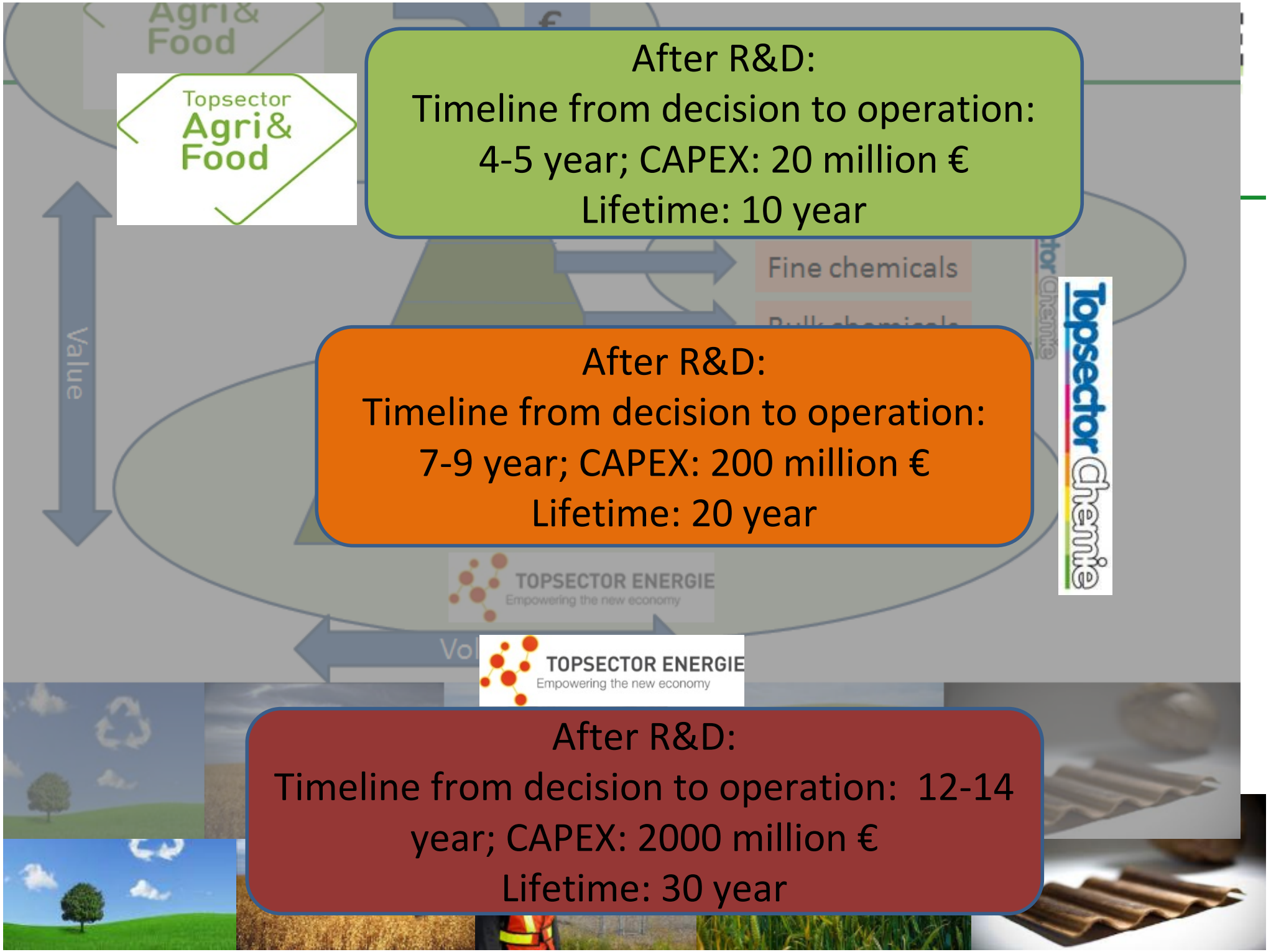
TKI Agri & Food

TS Chemistry

TKI Chemistry

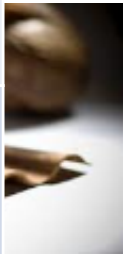
TKI BBE


Topsector Agri& Food
Biomass
€
Food
Pharma
Fine chemicals
Bulk chemicals
Jet fuel
Car fuel
Co-firing
Value
€
TOPSECTOR ENERGIE
Empowering the new economy
Volume
TKI•BBE
Topsector Agri& Food
Topsector Chemie


Agri&
Food
Topsector
Agri&
Food
After R&D:
Timeline from decision to operation:
4-5 year; CAPEX: 20 million €
Lifetime: 10 year
Fine chemicals
Value
Topsector Chemie
After R&D:
Timeline from decision to operation:
7-9 year; CAPEX: 200 million €
Lifetime: 20 year
TOPSECTOR ENERGIE
Empowering the new economy
TOPSECTOR ENERGIE
Empowering the new economy
After R&D:
Timeline from decision to operation: 12-14 year; CAPEX: 2000 million €
Lifetime: 30 year

Energy use as fuel (80%)

Application	Share (%)	Biobased option	Sustainable Alternative	Disadvantage
Elektricity/WKK	29%	Cofiring Bio WKK Gasification	Zon Wind	No 24/7 availability
Heat (< 120°C): homes, greenhouses, food & paper industry, etc…	22%	Bio WKK Biomass burner	Geowarmth Heat pump Solar boiler	€€€, insecure Decentral Decentral
Cars + small trucks	10%	Biofuels Biogas	El. Car (>10.000 in NL)	Range €€€, rare minerals, expensive infrastructure
Industrial heat (>120, steam)	15%	Biomass burner	-	(temperature too high for sustainable alternatives)
Large trucks	4%	Biofuels Biogas (LBG)	-	(Too much power needed for batteries)
Air transport (Consumption NL) Air transport (total in tanks)	0,1% 5%	Biofuels	-	(elektrical aeroplanes?)
Water transport (Consumption NL) Water transport (total in	0,5% 17%	Biofuels Biogas (LBG)	-	(Too much power needed for batteries)



Introduction to sunlight conversion

Slide: Jochem Wijten; UU, group Weckhuysen

Renewable energy is intermittent (day-night, winter-summer cycle of the sun): demand and generation does not overlap: storage is required.

1 AA battery: about 18 kJ; World energy consumption 2010: 1.500.000.000.000.000 kJ **per day**; thus 86.400.000.000.000 AA needed; This requires 12.960.000.000 tonnes of lithium which is 100 times more than available on earth. For one day.

=

10 drops of gasoline contains as much energy as 1 AA battery. Hydrogen contains even 3 times more energy per kilogram. Hence: Transforming solar energy into chemical energy Fuels produced this way are referred to as Solar Fuels.

Window of Operation (NL)

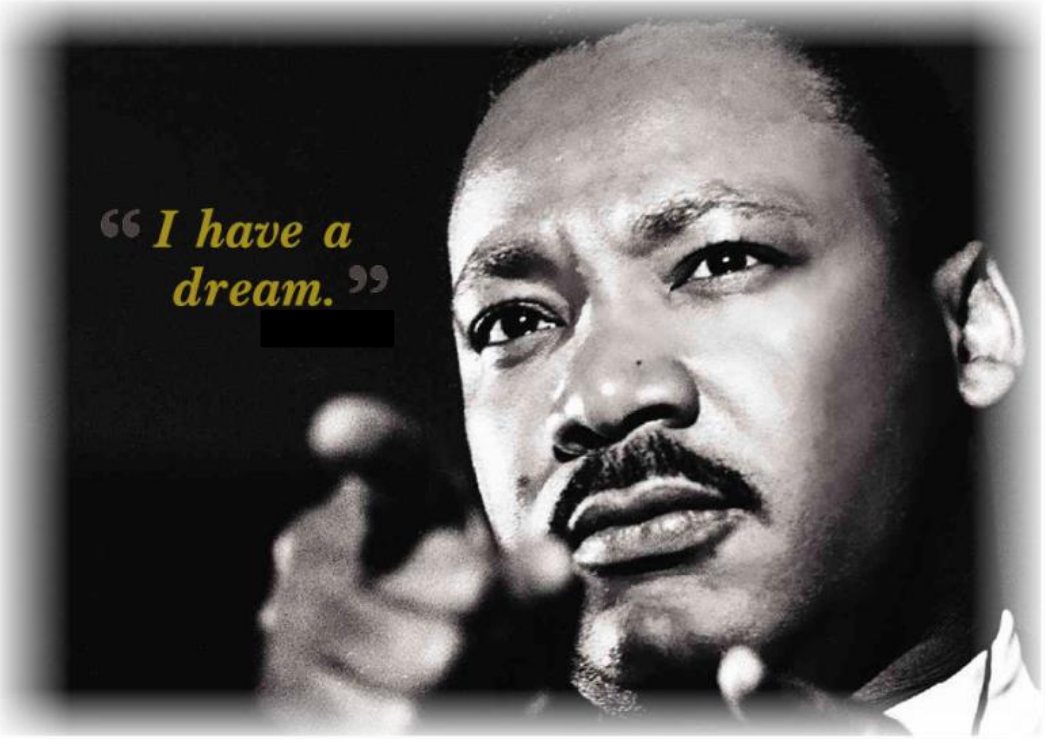
- Please settle three boxes (topsector policy):
  - Valorisation
  - Applied research
  - Basic research
- Settle three geographies:
  - International
  - National (especially cross-sectoral)
  - Regional
- And make SME's link.

Instruments irt Technology Readiness Level - ***NL***

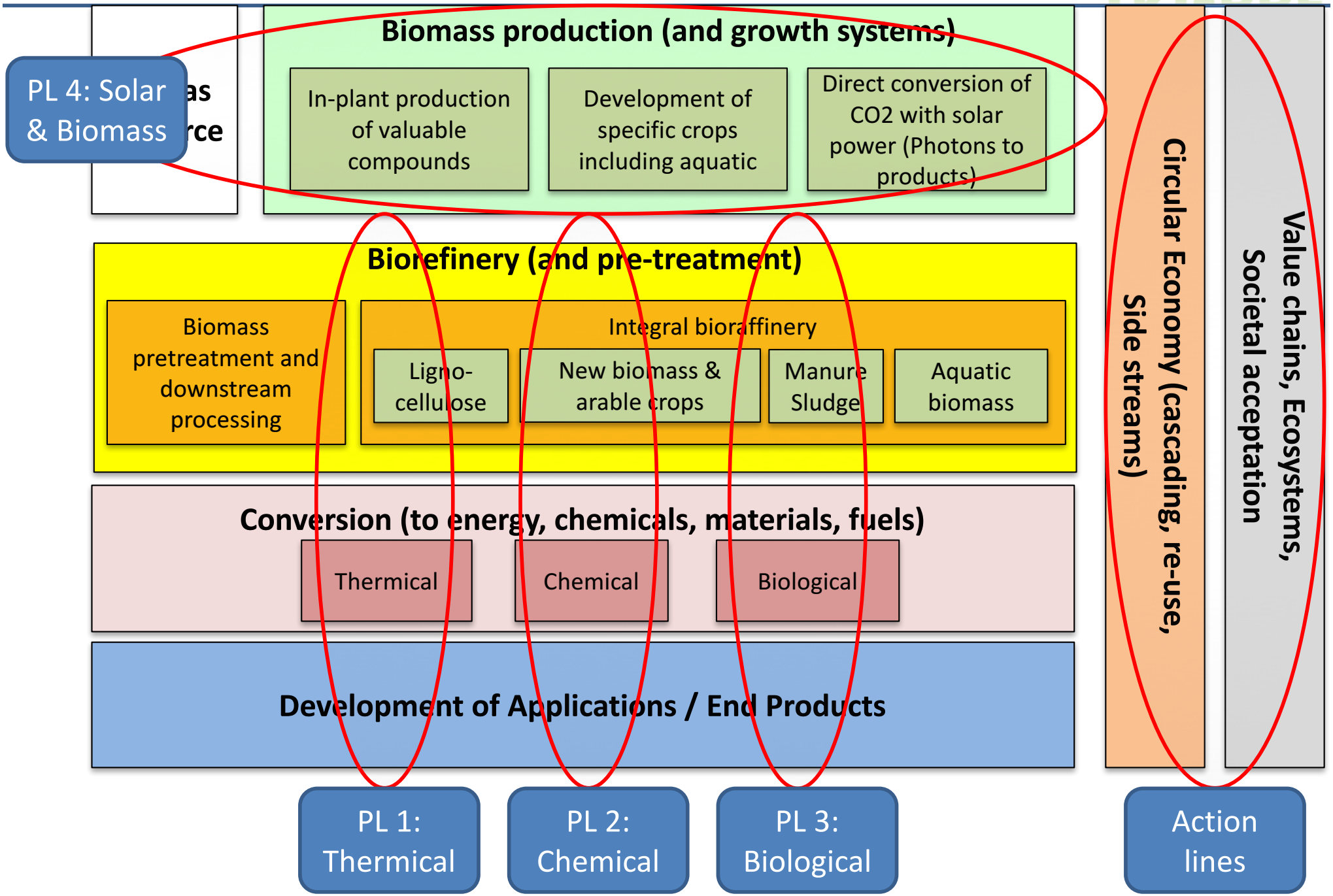
TKI•BBE
Topsector Agri& Food

Fundamental (NWO / Universities)	NWO Free programming (175M)	KNAW, Universities (>2 G€)	0-30
	NWO PPS programming (100M), STW (Partnership / Perspectief)	TKI-toeslag PPS	30-50
Applied (TO2 = DLO ECN TNO)	TO2 Strat.Innov.Progr.	TO2 MIP	
	TO2 PPS	TKI-toeslag PPS	50
		SIA/RAAK /CoE	
Valorisation (MIT / regio / anyone)	SME in Topsector (MIT)	IPC's	> 50
	Regional instruments	Demo's	
	Fiscal: Innovationbox; WBSO-RDA		

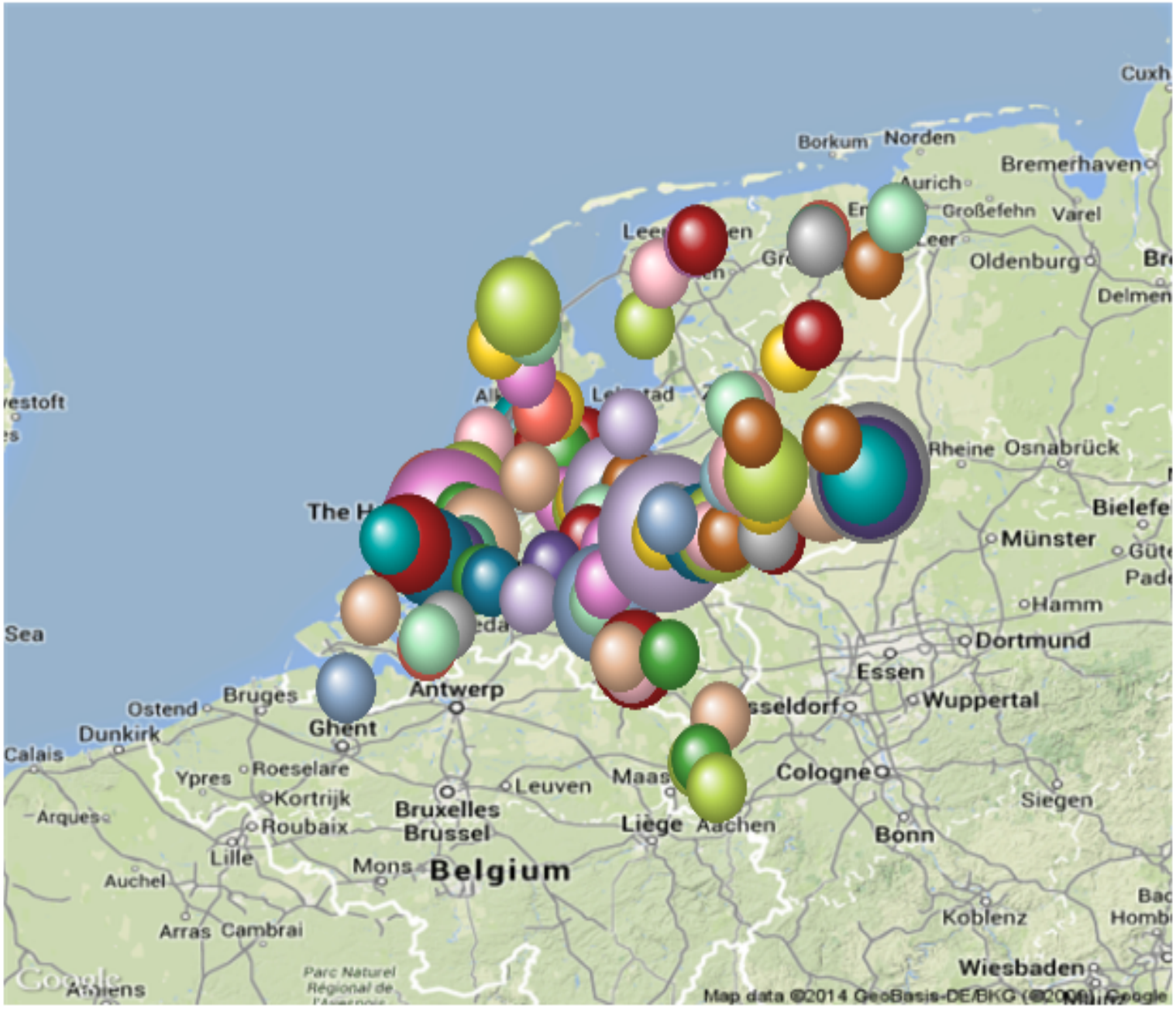
So?



Courtesy Maarten Schaafsma, Royal Haskoning


PL 4: Solar & Biomass
Biomass production (and growth systems)
In-plant production of valuable compounds
Development of specific crops including aquatic
Direct conversion of CO2 with solar power (Photons to products)
Biorefinery (and pre-treatment)
Biomass pretreatment and downstream processing
Integral bioraffinery
Ligno-cellulose
New biomass & arable crops
Manure Sludge
Aquatic biomass
Conversion (to energy, chemicals, materials, fuels)
Thermical
Chemical
Biological
Development of Applications / End Products
Circular Economy (cascading, re-use, Side streams)
Value chains, Ecosystems, Societal acceptation
PL 1: Thermical
PL 2: Chemical
PL 3: Biological
Action lines

Results so far: national...



www.tki-bbe.nl

THM 2.

- An integral agenda is needed.
- Non-accepted technology = no technology;
- Hygiene / Societa / Perception conflicts with the concept of th economy... ("sew

Plastic draagtasjes uit poep- en piesresten

Waterschap Brabantse Delta heeft bacteriën uit rioolwater met succes ertoe aangezet bioplastics te gaan produceren. De onderzoekers hebben in een proefproject gebruik gemaakt van bacteriën die eerst het afvalwater uit het ri zuiverden in een installatie zoals die overal in Nederland staan.

TKI BBE project

Innovative Process for Alginate production from Nereda® Sludge (iPANES)

Nereda®

The natural way of treating wastewater

Courtesy of Michiel Adriaanse, Kenniscentrum Papier en Karton

Maarten Schaafsma, Royal HaskoningDHV

As presented in Amsterdam, 23 juni 2015

stowa

Waterschap Rijn en IJssel

WATERBEHEER: VEILIG EN OP MAAT

KCPK

KENNISCENTRUM PAPIER EN KARTON

waterschap vallei en veluwe

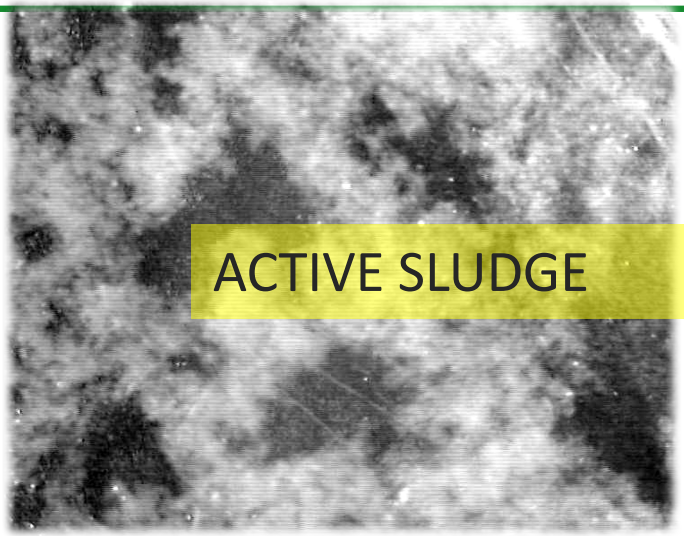
WATERSCHAP vechtstromen

TU Delft Delft University of Technology

Royal HaskoningDHV

Enhancing Society Together

Introducing Nereda

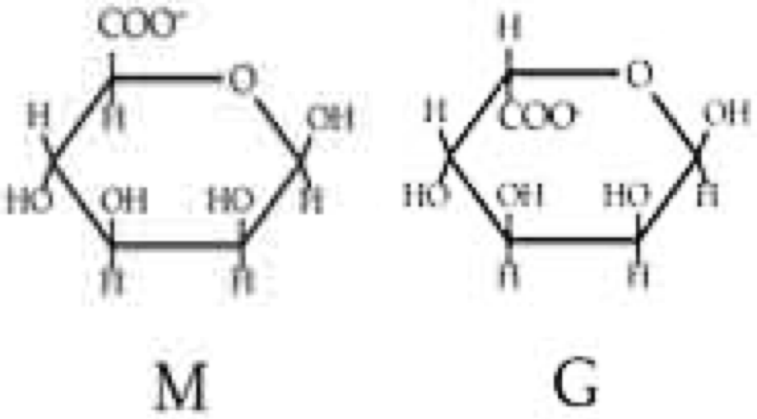


ACTIVE SLUDGE

ACTIVE SLUDGE NIBS

Introducing Alginate

Alginaat consists of 2 monomers (M- and G-blocks); nibs = 20%w alginate



Applications

- Paper — Glue & coating
- Textile — Gelling agent in ink
- Food — Gelling agent, coating, stabiliser
- Medical — Carrier, waterabsorbens, glue
- Horticulture — waterabsorbens, coating, growth enhancer
- Construction/Industry — coating of welding material and concrete

Example... For an issue

Upcycling Gemert BV

Champost: the remainder of champignon production.

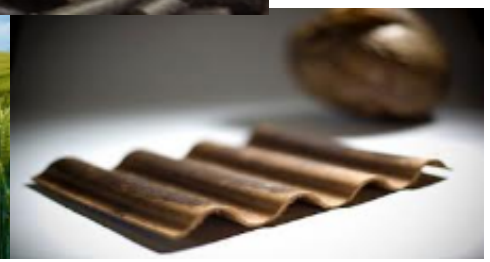
800.000 ton / year in NL.

Negative value.

Upcycling Gemert

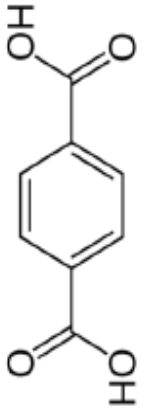
- Drying of champost, biological (!!).
- Product 1: Heat from the process to horticulture around the plant.
- Separation of champost in two streams (peat).
- Dry matter up to 90%.
- Product 2: biofuel or organic fertilizer (80 oC !)
- No subsidy on the exploitation!

Endproduct.



Opened september 12, ‘16

FDCA versus PTA; Avantium YXY technology

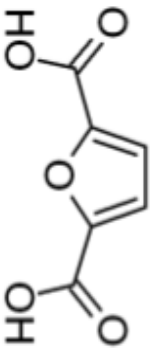


PTA

- Oil-based
- Building block for PET
- 50 million ton per year
- Today's price: €1200/ton
- Price drivers:
  - Oil price
  - Supply/demand

FDCA

- Bio-based
- Building block for PEF
- Potential market > 100 million ton
- Price at commercial scale: <€ 1000 per ton
- Price drivers:
  - Carbohydrate price
  - Economy of scale

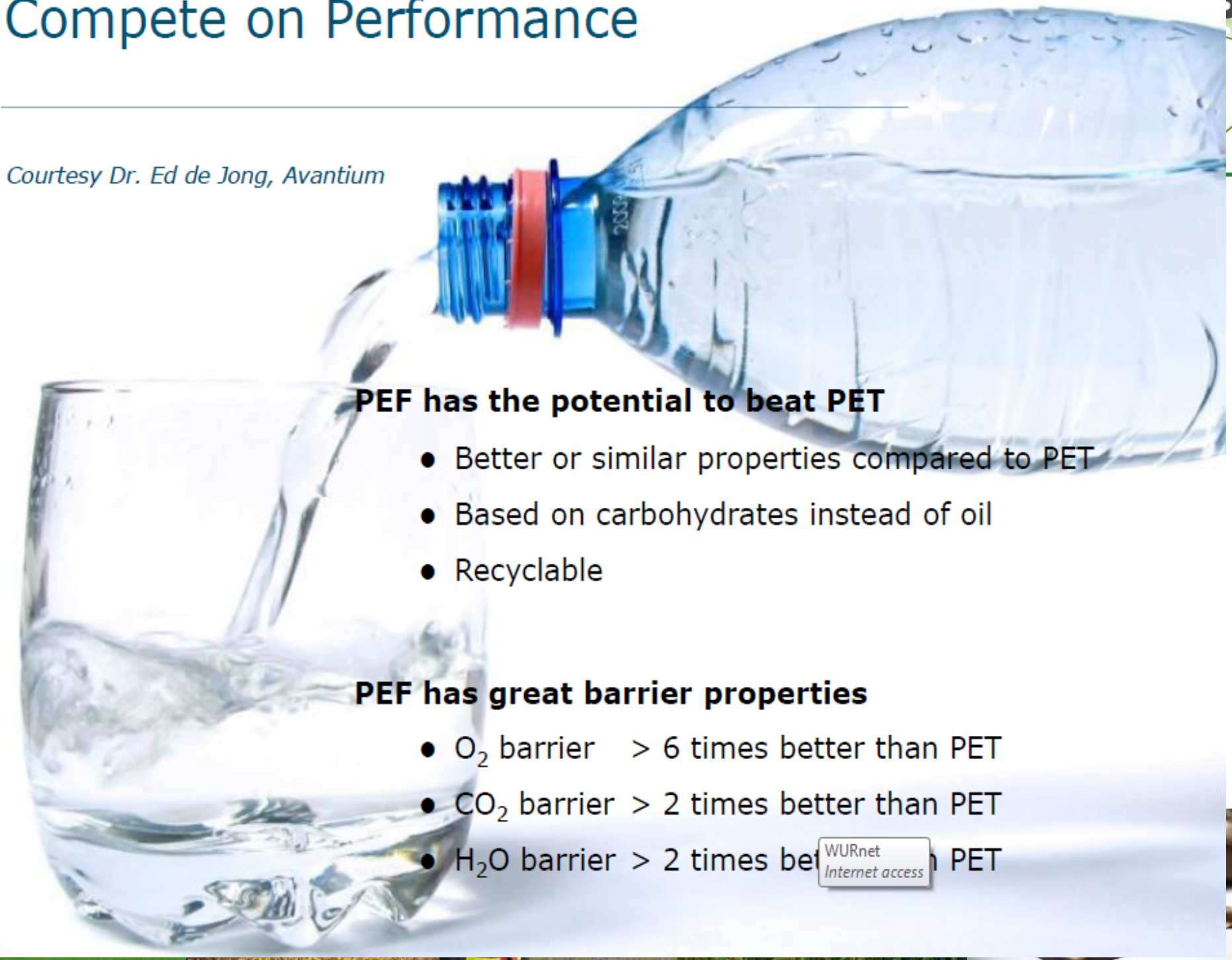


FOOD & BIOBASED RESEARCH
WAGENINGEN UR

Courtesy Ed de Jong, Avantium

Compete on Performance

Courtesy Dr. Ed de Jong, Avantium



PEF has the potential to beat PET

- Better or similar properties compared to PET
- Based on carbohydrates instead of oil
- Recyclable

PEF has great barrier properties

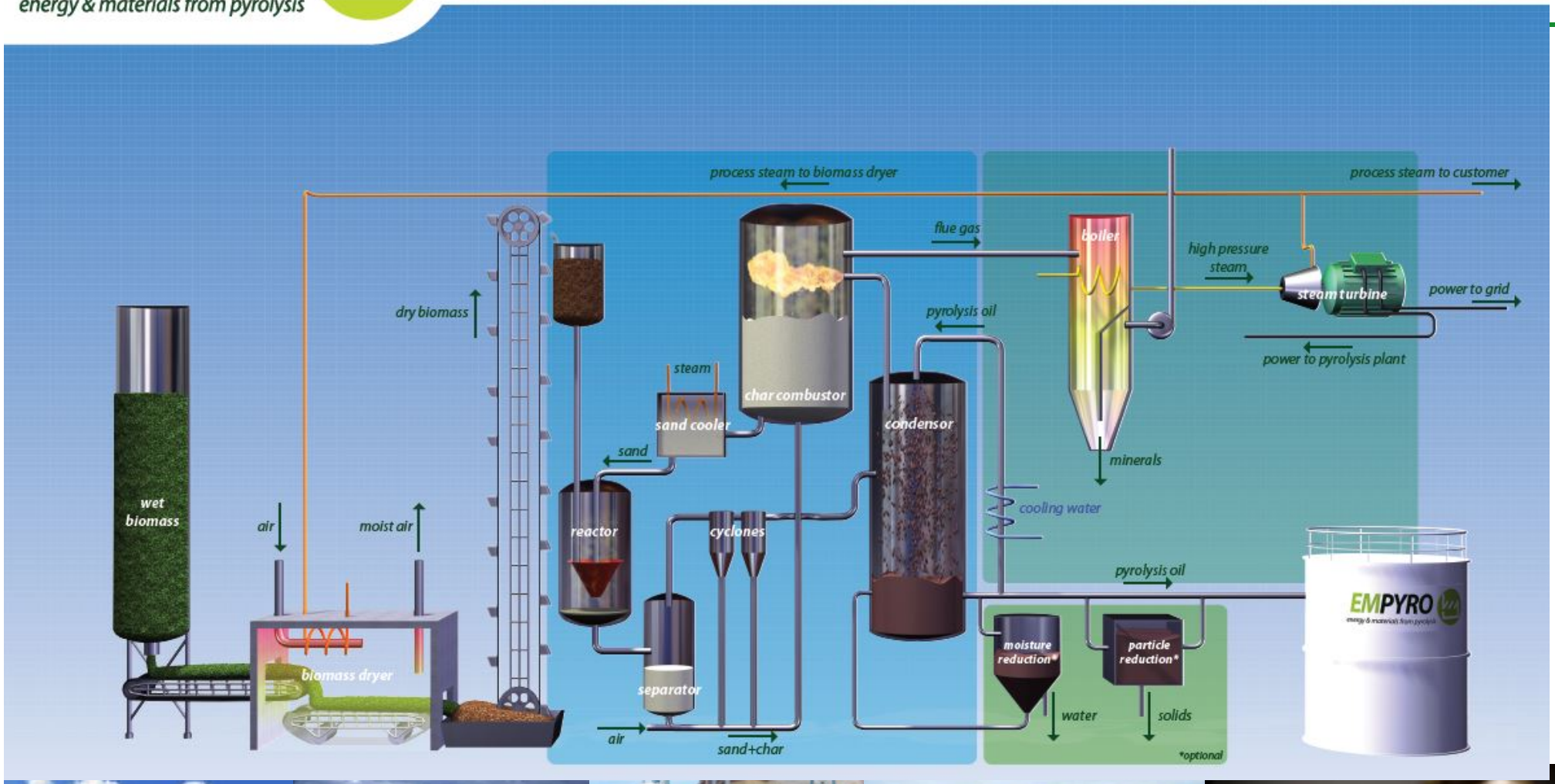
- O_2 barrier > 6 times better than PET
- CO_2 barrier > 2 times better than PET
- H_2O barrier > 2 times bet PET

Pyrolysis as building block for BBE

TKI-BBE, Amsterdam, 23 juni 2015

EMPYRO – flowsheet

EMPYRO
energy & materials from pyrolysis

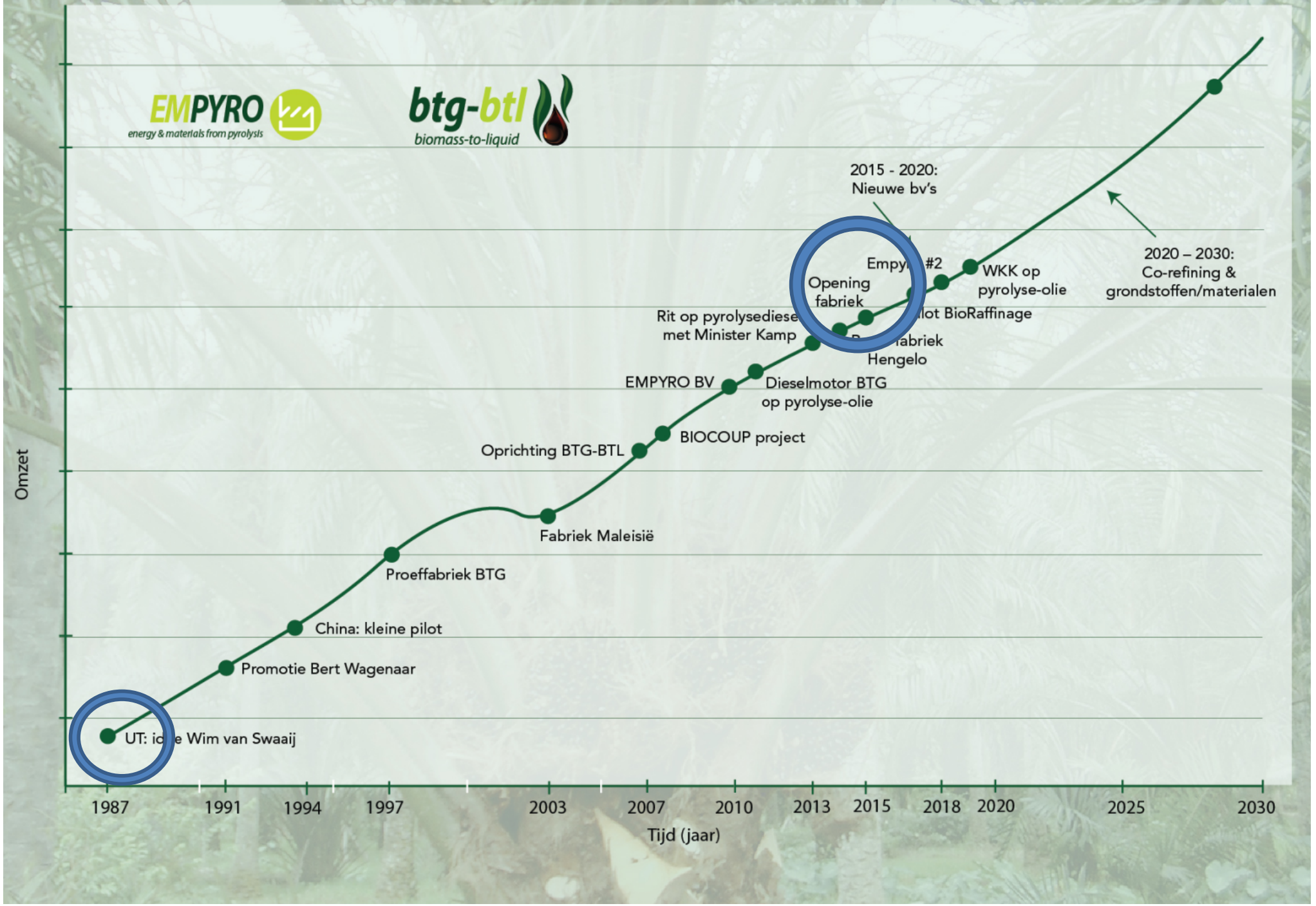


Simplified scheme of the Empyro Fast Pyrolysis Plant

EMPYRO – plant

Empyro plant - March 2015

Toekomst


EMPYRO
energy & materials from pyrolysis
btg-btl
biomass-to-liquid
2015 - 2020:
Nieuwe bv's
2020 – 2030:
Co-refining &
grondstoffen/materialen
Empy #2
WKK op
pyrolyse-olie
Opening
fabriek
Rit op pyrolysediese
met Minister Kamp
lot BioRaffinage
fabriek
Hengelo
EMPYRO BV
Dieselmotor BTG
op pyrolyse-olie
BIOCOUP project
Oprichting BTG-BTL
Fabriek Maleisië
Proeffabriek BTG
China: kleine pilot
Promotie Bert Wagenaar
UT: id e Wim van Swaaij
Omzet
1987
1991
1994
1997
2003
2007
2010
2013
2015
2018
2020
2025
2030
Tijd (jaar)

THM 3

- Most installations / plants will be significantly smaller than we are used to on a fossil basis.
- Most business cases have to sell the residual heat to be healthy.
- Hence: they have to be built near living areas...

Biofuels, according to the Nuffield Council on Bioethics

1) Biofuels development should not be at the expense of people's essentia rights (including access to sufficient food and water, health rights, work

Could we impose these principles to fossil fuels as well, please?

2) Biofuels should be environmentally sustainable.
3) Biofuels should contribute to a net reduction of total greenhouse gas emissions and not exacerbate global climate change.
4) Biofuels should develop in accordance with trade principles that are fair and recognize the rights of people to just reward (including labour rights and intellectual property rights).
5) Costs and benefits of biofuels should be distributed in an equitable way.

6) If the first five Principles are respected and if biofuels can play a crucial role in mitigating dangerous climate change then, depending on additional key considerations, **there is a duty to develop such biofuels.**

Nuffield Council on Bioethics, "Biofuels: Ethical Issues" (http://www.nuffieldbioethics.org/biofu

TKI•BBE

Topsector
Agri&
Food